Analyzing the Ohio Valley Region's Tornado Climatology, 1960–2018

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Why is This Subject Important?

- Ohio Valley (OV) tornadoes vastly understudied.
- This research creates a basic tornado climatology.
- Provides a basis for future research to expand our knowledge.

Figure 1: A tornado captured three miles to the northwest of Berne, Indiana on August 24th, 2016. This was one of 14 tornadoes recorded across Northwest Ohio and Northeast Indiana that day.[1]

What Do We Already Know? What Questions Does This Spur?

- Most prior tornado research focuses on Great Plains and southeastern United States, not OV.[2]
- Evidence suggests "Tornado Alley" – region of most tornadic activity – is extending eastward.[3]
- Historically, date of highest tornado activity in central OH is May 15th; is this changing over time?[2]
- Previous research on tornado climatology excludes other OV states (IL,IN).[2]
- Is seasonality of tornado activity changing throughout the OV states?
- What patterns emerge by examining monthly OV tornado activity (frequency and intensity)?

Data and Methods

- Storm Prediction Center's comprehensive tornado base (1950-2018).[4]
- Normal periods analyzed were 1960-1989 and 1990-2018.
- Third period created and split 1990 period into two: 1990-2006 and 2007-2018.
- CSV file and analyzed using Python in Jupyter notebook.
- End goal was to create histograms of tornado frequencies by month and intensity.

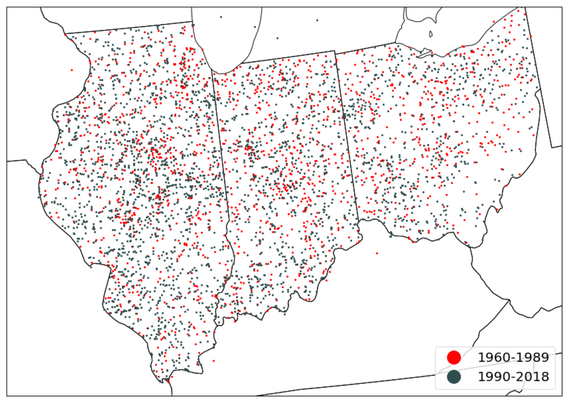


Figure 2: Dot map showing all recorded tornadoes for the Ohio Valley Region for 1960-1989 and 1990-2018 periods.[5]

Results

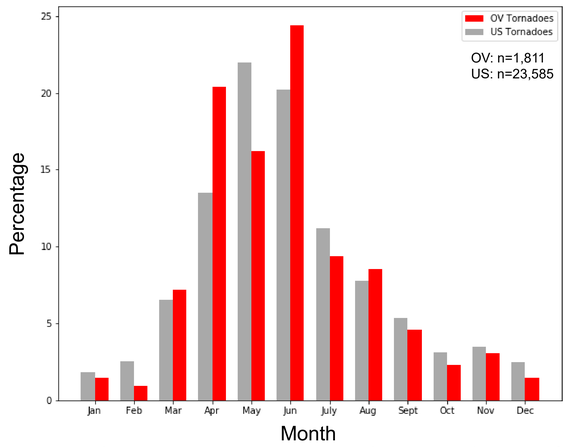


Figure 3: Ohio Valley tornadoes compared to the United States tornadoes for 1960-1989.[6]

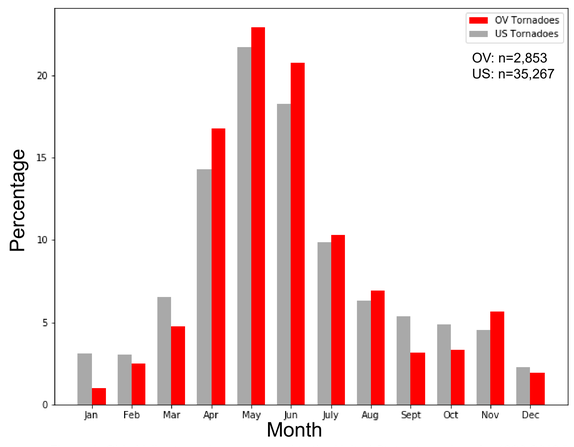


Figure 4: Ohio Valley tornadoes compared to the United States tornadoes for 1990-2018.[7]

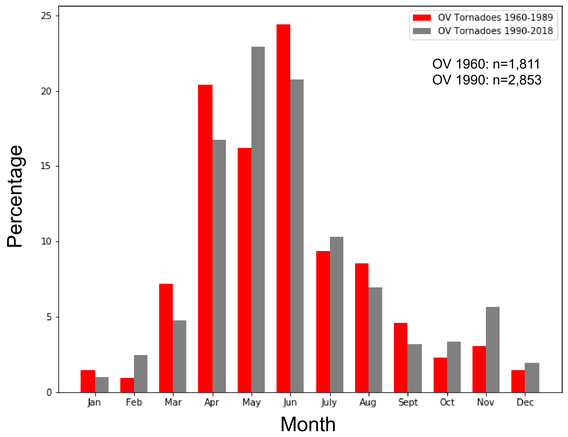


Figure 5: Ohio Valley tornadoes by month for 1960 to 1989.[8]

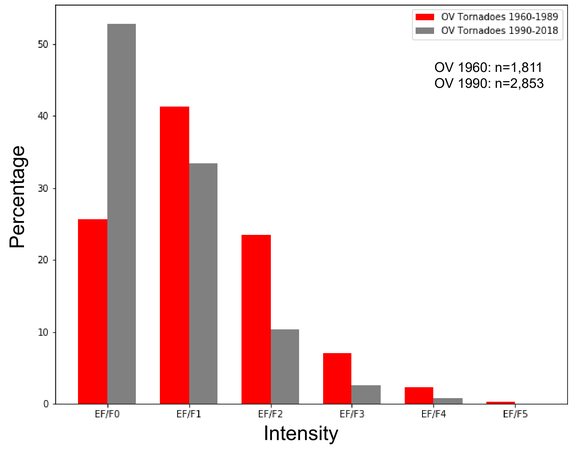


Figure 6: Ohio Valley tornadoes by intensity for 1960-1989 and 1990-2018.[9]

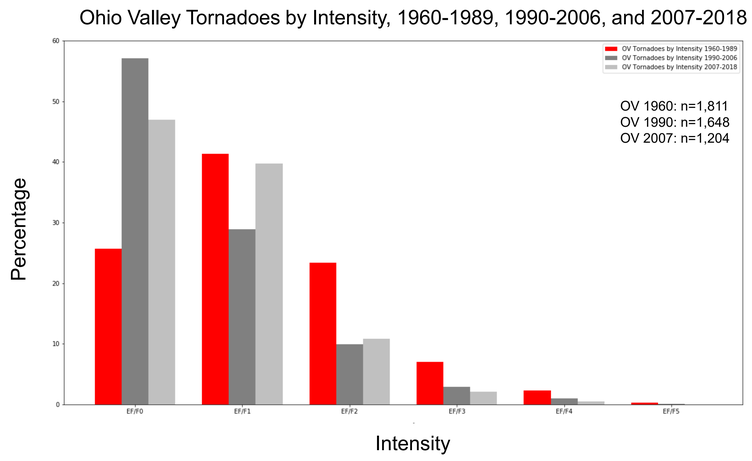


Figure 7: Ohio Valley tornadoes by intensity for 1960-1989, 1990-2006, and 2007-2018.[10]

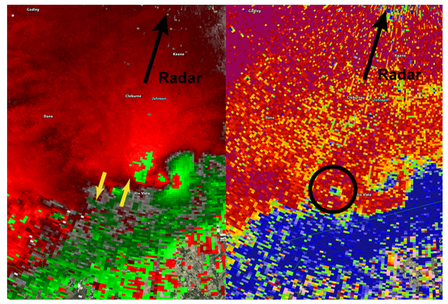
EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Figure 8: Current tornado rating system, known as the Enhanced Fujita scale, introduced in 2007.[11]

- Between 1960 and 1990 period, shift in the month of peak tornado occurrence for the Ohio Valley.
- For OV, more tornadoes recorded in May and November in 1990-2018.
- An increase of almost 25% in weaker tornadoes recorded in the more recent period.
- Drop-off in 2007-2018 in weak tornadoes vs strong tornadoes recorded.
- Weaker tornadoes appear to be more common today.

Discussion and Conclusions

- Overall increase of tornadoes seen between periods.
- Could be explained by technological advances:
  - ❑ 1950s: First tornado reports[12]
  - ❑ 1965: Palm Sunday outbreak (SKYWARN created shortly after)[12]
  - ❑ 1971: Creation of Fujita scale[13]
  - ❑ 1974: Super Outbreak (more Doppler research)
  - ❑ 1990: New Doppler radar technology starts installation across country[14]
  - ❑ 1997: All NWS offices have updated radar[14]
  - ❑ 2000s: New Doppler products introduced to better detect weaker tornadoes (correlation coefficient)[15]
  - ❑ 2007: Implementation of Enhanced Fujita scale
  - ❑ 2010s: Introduction of drone technology to better identify tornadoes vs downbursts vs straight line winds
- Could also indicate real changes in climate forcing.
- Tornado occurrences show discernible shifts in each season.
- Future research possibilities:
  - ❑ Examine diurnal vs nocturnal occurrence
  - ❑ Analyze changes in occurrence by intensity
  - ❑ Case studies of outbreaks in OV – explore weather and climate conditions, attribution of climate change



Figures 9 and 10: An example of new Doppler products and the SKYWARN logo, respectively.[15,16]

References

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5-10: Figures provided by Alyssa Reynolds, author.
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